

The following is a complete listing of all claims in the application, with an indication of the status of each:

**Listing of claims:**

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- 1        1. (currently amended) A method of managing manufacturing logistics of end  
2        products comprising the steps of:  
3                maintaining an inventory of components, which components, termed  
4        “building blocks”, are built to stock, each said component having a cost;  
5                configuring-to-order end products using said components;  
6                establishing a base-stock level for each of said components; and  
7                replenishing said components from suppliers ~~following a base-stock~~  
8        ~~policy that establishes a base-stock level for each of said components that~~  
9        ~~minimizes in accordance with said base-stock levels so as to reduce a total~~  
10       ~~cost of inventory of said components,~~  
11               wherein said cost of at least one component differs from said cost of at  
12       least one other component.
- 1        2. (original) The method of managing manufacturing logistics of end  
2        products recited in claim 1, wherein the end products are personal computers  
3        (PCs) and the components are stock computer components.
- 1        3. (original) The method of managing manufacturing logistics of end  
2        products recited in claim 1, wherein the base-stock levels are derived from a  
3        greedy algorithm which iteratively reduces inventory budget until a budget  
4        constraint is satisfied.

1 4. (currently amended) A computer implemented process of managing  
 2 manufacturing logistics of configure-to-order end products comprising the  
 3 steps of:

4 a) initializing a process of managing manufacturing logistics of  
 5 configure-to-order end products by setting  $x_i := 0$  for each  $i \in S$ , setting  $r_{mi} :=$   
 6  $P(X_{mi} > 0)$ , setting  $\beta_m := 0$  for each  $m \in M$ , and setting  $\beta := 0$ , where  $S$  is a set  
 7 of components indexed by  $i$ ,  $M$  is a set of end products indexed by  $m$ ,  $x_i$  is a  
 8 probability of no-stockout of a component of index  $i$ ,  $r_{mi}$  is a probability that  
 9 a positive number of units of component  $i$  is used in the assembly of an end  
 10 product indexed by  $m$ ,  $\beta_m$  is a probability of stockout of an end product of  
 11 index  $m$ , and  $\beta$  is an upper limit on the stockout probability over all end  
 12 products;

13 b) setting a set of active components to  $A := \{\}$ ;

14 c) considering each  $i \in S$ , followed by considering each end product  $m$   
 15 that uses component  $i$  in its bill-of-material;

16 d) setting  $\beta_m := \beta_m + r_{mi} \Delta$ , for all  $m$  such that  $i \in S_m$  where  $\Delta$  is a unit  
 17 step size;

18 e) computing the a difference  $\delta_i := \max_m \{\beta_m\} - \beta$ ;

19 f) determining if  $\delta_i \leq 0$ , and if so, then adding component index  $i$  to the  
 20 set of active components,  $A := A + \{i\}$ ;

21 g) determining if the set of active components is non-empty, and if so,  
 22 then setting  $B := A$ , otherwise setting  $B := S$  where  $B$  is a set of component  
 23 indexes;

24 h) finding  $i^* := \arg \max_{i \in B} \{-c_i \sigma_i / r_{mi} g'(x_i + \Delta/2)\}$ , where  $-g'(\bullet)$  follows  
 25 the equation  $-g'(x) = -\Phi(\bar{\Phi}^{-1}(x)) \cdot \frac{-1}{\phi(\bar{\Phi}^{-1}(x))} = \frac{1-x}{\phi(\bar{\Phi}^{-1}(x))}$ , where  $\Phi(\cdot)$  is a

26 probability distribution function of the standard normal variate, and  $\phi(\cdot)$  is a  
 27 probability density function of the standard normal variate;

28 i) setting  $x_i^* := x_i^* + \Delta$  to update the probability of no-stockout of  
 29 component  $i^*$ ;

30 j) computing  $\beta := \max_{m \in M} \beta_m$ , and checking whether inequality  
 31  $\sum_{i \in S} c_i \sigma g(x_i) \leq B$ , where  $B$  is the budget limit on the expected overall

32 inventory cost, is satisfied and if so, stop and replenish components identified  
 33 by said set  $B$  from suppliers following a base-stock policy that minimizes a  
 34 total cost of inventory of said components  $i$ .

35 wherein said cost  $c_i$  of at least one component differs from said cost  
 36  $c_i$  of at least one other component ;

37 k) otherwise, updating  $\beta_m$  and for each  $m \in M_{i^*}$ , set  $\beta_m := \beta_m + r_{mi} \Delta$ , and  
 38 going to step b).

1 5. (currently amended) A system for managing manufacturing logistics of  
 2 end products comprising:  
 3 means for maintaining an inventory of components, which  
 4 components, termed "building blocks", are built to stock, each said component  
 5 having a cost;  
 6 means for configuring-to-order end products using said components;  
 7 means for establishing a base-stock level for each of said components;  
 8 and  
 9 means for replenishing said components from suppliers ~~following a~~  
 10 ~~base-stock policy that establishes a base-stock level for each of said~~  
 11 ~~components that minimizes in accordance with said base-stock levels so as to~~  
 12 reduce a total cost of inventory of said components.

13                    wherein said cost of at least one component differs from said cost of at  
 14                    least one other component.

1                    6. (original) The system for managing manufacturing logistics of end  
 2                    products recited in claim 5, wherein the end products are personal computers  
 3                    (PCs) and the components are stock computer components.

1                    7. (original) The system for managing manufacturing logistics of end  
 2                    products recited in claim 5, wherein the base-stock levels are derived from a  
 3                    greedy algorithm which is iteratively computed by a processing unit to reduce  
 4                    inventory budget until a budget constraint is satisfied.

1                    8. (currently amended) A method that translates end-product demand forecast  
 2                    in an assemble-to-order (ATO) environment into a forecast for components,  
 3                    taking into account outbound leadtime comprising the steps of:  
 4                                       defining in an assemble-to-order (ATO) environment an end product  
 5                    demand  $D_m(t)$  of type  $m$  in period  $t$ , each unit of type  $m$  demand requiring a  
 6                    subset of components, denoted  $S_m \subseteq S$ , as

7                    
$$D_i(t) = \sum_{m \in M_i} D_m(t + L_m^{\text{out}}); \text{ [and]}$$

8                    deriving mean and variance for component demand  $D_i(t)$  as

9                    
$$E[D_i(t)] = \sum_{m \in M_i} \sum_t E[D_m(t + \ell)] P[L_m^{\text{out}} = \ell], \text{ and}$$

$$\begin{aligned} \text{Var}[D_i(t)] = & \sum_{m \in M_i} \sum_t E[D_m^2(t+\ell)] P[L_m^{\text{out}} = \ell] \\ & - \sum_{m \in M_i} \left( \sum_t E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell] \right)^2, \text{ respectively; and} \end{aligned}$$

replenishing said components from suppliers following a base stock policy that minimizes a total cost of inventory of said components, each said component having a cost, wherein said cost of at least one component differs from said cost of at least one other component.

9. (original) The method recited in claim 8, wherein the ATO environment is extended to a configure-to-order (CTO) environment for stationary demand, taking into account batch sizes comprising the steps of:  
translating end-product demand into demand for each component  $i$  (per period) as

$$D_i = \sum_{m \in M_i} \sum_{k=1}^{D_m} X_{mi}(k).$$

where  $X_{mi}(k)$ , for  $k = 1, 2, \dots$ , are independent, identically distributed (i.i.d.) copies of  $X_{mi}$ ;  
deriving marginal distributions, and then the mean and the variance of  $X_{mi}$  as

$$E[D_i] = \sum_{m \in M_i} E[X_{mi}] E[D_m], \text{ and}$$

12 
$$\begin{aligned} \text{Var}[D_i] &= \sum_{m \in M_i} \left( E[D_m] \text{Var}[X_{mi}] + \text{Var}[D_m] E^2[X_{mi}] \right) \\ &= \sum_{m \in M_i} \left( E^2[X_{mi}] E[D_m^2] + \text{Var}[X_{mi}] E[D_m] - E^2[X_{mi}] E^2[D_m] \right), \text{ respectively.} \end{aligned}$$

1 10. (original) The method recited in claim 9, extended to non-stationary  
2 demand, wherein the mean and the variance of  $X_{mi}$  are generalized as

3 
$$E[D_i(t)] = \sum_{m \in M_i} E[X_{mi}] \sum_t E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell], \text{ and}$$

4 
$$\begin{aligned} \text{Var}[D_i(t)] &= \sum_{m \in M_i} E^2(X_{mi}) \sum_t E[D_m^2(t+\ell)] P[L_m^{\text{out}} = \ell] \\ &\quad + \sum_{m \in M_i} \text{Var}(X_{mi}) \sum_t E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell] \\ &\quad - \sum_{m \in M_i} E^2(X_{mi}) \left( \sum_t E[D_m(t+\ell)] P[L_m^{\text{out}} = \ell] \right)^2, \text{ respectively.} \end{aligned}$$

1 11. (currently amended) The method recited in claim 9, further comprising  
2 the steps of:

3 defining  $R_i(t)$  as a reorder point (or, base-stock level) in period  $t$  as

4 
$$R_i(t) := \mu_i(t) + k_i(t) \sigma_i(t),$$

5 where  $k_i(t)$  is ~~the~~ a desired safety factor, while  $\mu_i(t)$  and  $\sigma_i(t)$  can be derived  
6 (via queuing analysis) as

7 
$$\mu_i(t) = \sum_{s=t}^{t+\ell_i^{\text{in}}-1} E[D_i(s)], \text{ and}$$

8 
$$\sigma_i^2(t) = \sum_{s=t}^{t+\ell_i^{\text{in}}-1} \text{Var}[D_i(s)], \text{ respectively,}$$

9 where  $\ell_i^{\text{in}} := E[L_i^{\text{in}}]$  is expected in-bound leadtime; and

10 translating  $R_i(t)$  into “days of supply” (DOS), where the  $\mu_i(t)$  part of  
 11  $R_i(t)$  translates into periods of demand and the  $k_i(t)\sigma_i(t)$  part of  $R_i(t)$  is turned  
 12 into

13 
$$\frac{\frac{k_i(t)\sigma_i(t)}{\mu_i(t)}}{\ell_i^{\text{in}}}$$

14 periods of demand so that  $R_i(t)$  is expressed in terms of periods of DOS as

15 
$$\text{DOS}_i(t) = \ell_i^{\text{in}} \left[ 1 + k_i(t) \frac{\sigma_i(t)}{\mu_i(t)} \right].$$

1 12. (original) The method recited in claim 11, wherein demand is stationary  
 2 in which for each demand class  $m$ ,  $D_m(t)$  is invariant in distribution over time,  
 3 so that the mean and the variance of demand per period for each component  $i$   
 4 reduce to

5  $\mu_i = \ell_i^{\text{in}} E[D_i]$ , and  $\sigma_i^2 = \ell_i^{\text{in}} \text{Var}[D_i]$ , respectively, and

6  $R_i = \ell_i^{\text{in}} E[D_i] + k_i \sqrt{\ell_i^{\text{in}}} \text{sd}[D_i]$ , and hence,

7 
$$\text{DOS}_i = \frac{R_i}{E[D_i]} = \ell_i^{\text{in}} + k_i \theta_i \sqrt{\ell_i^{\text{in}}} = \ell_i^{\text{in}} \left[ 1 + k_i \frac{\theta_i}{\sqrt{\ell_i^{\text{in}}}} \right],$$

8 where  $\theta_i := \text{sd}[D_i]/E[D_i]$  is the coefficient of variation of the demand *per*  
 9 *period* for component  $i$ , and hence  $\theta_i / \sqrt{\ell_i^{\text{in}}}$  is the coefficient of variation of the  
 10 demand over the leadtime  $\ell_i^{\text{in}}$ .

1 13. (currently amended) A method that relates service requirements to  
 2 base-stock levels of components in an assemble-to-order (ATO) environment  
 3 comprising the steps of:

4 defining in an assemble-to-order (ATO) environment each order of  
 5 type  $m$  as requiring exactly one unit of component  $i \in S_m$ ,  $\alpha$  as a required  
 6 service level, referred to as off-shelf availability of all the components  
 7 required to configure a unit of type  $m$  product, for any  $m$ , and  $E_i$  as an event  
 8 that component  $i$  is out of stock;

9 determining a probability  $P$  for each end product  $m \in M$ ,

10 
$$P[\cup_{i \in S_m} E_i] \leq 1 - \alpha, \text{ and}$$



$$11 \quad P[\cup_{i \in S_m} E_i] = \sum_i P(E_i) - \sum_{i < j} P(E_i \cap E_j) + \sum_{i < j < k} P(E_i \cap E_j \cap E_k) - \dots, \text{ and}$$

$$12 \quad P[\cup_{i \in S_m} E_i] \approx \sum_{i \in S_m} P(E_i) = \sum_{i \in S_m} \bar{\Phi}(k_i) \leq 1 - \alpha; \text{ and}$$

13 establishing base stock levels for each component  $i$  that minimize a  
 14 total cost of inventory of said components, each said component having a cost,  
 15 wherein said cost of at least one component differs from said cost of at  
 16 least one other component.

1 14. (previously presented) The method recited in 13, wherein the method is  
 2 extended to a configure-to-order (CTO) environment taking into account batch  
 3 sizes, further comprising the steps of:

4 defining  $A \subseteq S_m$  as a certain configuration, which occurs in a demand  
 5 stream with probability  $P(A)$ ;

6 weighting a no-stockout probability,  $\prod_{i \in A} \Phi(k_i)$ , by  $P(A)$ ;

7 changing the service requirement to

$$\begin{aligned} \alpha &\leq \sum_{A \subseteq S_m} P(A) \prod_{i \in A} \Phi(k_i) \\ &\approx \sum_{A \subseteq S_m} P(A) [1 - \sum_{i \in A} \bar{\Phi}(k_i)] \\ 8 \quad &= 1 - \sum_{A \subseteq S_m} P(A) \sum_{i \in A} \bar{\Phi}(k_i) \\ &= 1 - \sum_{i \in S_m} \left( \sum_{A \ni i} P(A) \right) \bar{\Phi}(k_i); \text{ and} \end{aligned}$$

9 extending the CTO environment the service requirement to

10 
$$\sum_{i \in S_m} r_{mi} \bar{\Phi}(k_i) \leq 1 - \alpha$$

11 where  $r_{mi}$  is the probability that a positive number of units of component  $i$  is  
12 used in the assembly of an end product indexed by  $m$ .

1 15. (currently amended) A method that translates service requirements in  
2 terms of leadtimes into requirements for off-shelf availability of components  
3 comprising the steps of:

4 relating an off-shelf availability requirement to standard customer  
5 service requirements expressed in terms of leadtimes,  $W_m$ , where a required  
6 service level of type  $m$  demand is

7 
$$P[W_m \leq w_m] \geq \alpha, \quad m \in M,$$

8 where  $w_m$ 's are given data and  $P$  is probability;

9 when there is no stockout at any store  $i \in S_m$ , denoting the associated  
10 probability as  $\pi_{0m}(t)$ , a delay being  $L_i^{\text{out}}$ , the out-bound leadtime;

11 when there is a stockout at one or several stores in the subset  $s \subseteq S_m$ ,  
12 denoting the associated probability as  $\pi_{sm}(t)$ , so that the delay becomes  
13  $L_i^{\text{out}} + \tau_s$ , where  $\tau_s$  is the additional delay before the missing components in  $s$

14 become available;

15 determining  $P[W_m \leq w_m] = \pi_{0m}(t)P[L_m^{\text{out}} \leq w_m] + \sum_{s \in S_m} \pi_{sm}(t)P[L_m^{\text{out}} + \tau_s \leq w_m];$

16 assuming that

17  $L_m^{\text{out}} \leq w_m$  and  $L_m^{\text{out}} + \tau_s > w_m$

18 both hold *almost surely*, so that when the (nominal) outbound leadtime is  
19 nearly deterministic and shorter than what customers require, whereas the  
20 replenish leadtime for any component is substantially longer; and

21 replenishing said components from suppliers following a base stock  
22 policy that minimizes a total cost of inventory of said components, each said  
23 component having a cost,

24 wherein said cost of at least one component differs from said cost of at  
25 least one other component.

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